it uniformly, when in reality the hot gases may circulate only in the upper portion of the heating chamber, without coming into any contact with the material which has been placed upon the hearth. The utilization of the heat in this case will be very inefficient. The stream of fire which flows against the roof will carry all of its heat to the chimney.

The reason for this lies in the high coefficient of expansion of gases, that is to say, in the fact that their density diminishes very rapidly as their temperature increases. Therefore, the hydrostatic equilibrium of the different layers of gases, which are at different temperatures, is accomplished with great rapidity, and the hottest gases tend to accumulate at the highest point in the furnace. Take, for example, the case of a kiln for bricks, having a height of 5 meters and an average temperature of 1000° and assume that the hot gas issuing from the fireboxes has, where it enters the kiln, a temperature 500° higher, or 1500°. The motive pressure caused by this difference in temperature, acting upon a column of gases 5 meters in height, tends to produce, in the column of hot gases a vertical velocity of 5 meters per second, while the average velocity of the gases, as referred to the total area of the kiln chamber, is perhaps one-fiftieth of this velocity. The gases, therefore, have ample time to arrange themselves in layers according to their relative density. If the opening for the escape of the waste gases is located at the highest point of the roof of the furnace, the greatest portion of the heat will be lost. It is necessary, in order to avoid such heat loss, to employ the downdraft principle of heating, which has been employed for a long time in the manufacture of porcelain and faience, but which still remains unknown in a great many other industries.

By numerous examples, the author of this

volume shows that at least one-half of the furnaces designed for high-temperature heating are arranged in such a manner that the currents of hot gases tend to isolate themselves in the heating chamber, thus giving an extremely poor utilization of the heat released by the combustible.

The formation of these streams of hot gases in the furnace is the cause of another difficulty; they tend to retard the completion of the reaction of combustion. Above a fire burning upon a grate, there are a number of parallel currents of gas, some of which contain an excess of oxygen, while others contain an excess of